4: Joseph et al D,E-5 (1942-1943) 1949
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but the summer storms come suddenly, the clouds pouring out water and then disappearing as quickly as they came. Rainfall varies greatly on different parts of the Reservation. In the southeastern districts where the mountains are highest, annual precipitation reaches an average of 18 inches in the mountains and about 13 inches in the valleys. Most of the permanent springs and the few small streams that flow for nine months in wet years are located in the foothills of this area. From the center of the Reservation westward, rainfall decreases progressively, averaging only 5 inches in Gu Vo District. Averages give no realistic picture, however, for years of good rainfall are often followed by years in which the washes do not flow at all. The year 1943, when the field work for this study was done, was one of extreme drought, perhaps the worst in history.

Temperature also fluctuates greatly. Winters are mild, with many sunny days, but sometimes the winds are raw and cold, and at night the thermometer may fall to 15° Fahrenheit. Sometimes snow falls on the higher mountains and may remain several days. The summer, from May through September, is extremely hot, with daytime temperatures usually exceeding 100° and often soaring to 120°. Daily range of temperature is wide; the average daily maximum and minimum are 82.5° and 51.1°—an average daily change of 31.4°.

Soils on the Reservation are generally of very good quality: lack of water is the prime factor limiting production. Hence the more arid western districts have a much lower proportion of farm lands and lower range carrying capacity than the central and eastern districts.

Like rainfall, vegetation varies with elevation. On the valley floors are miles and miles of cholla cactus and almost useless creosote bush,[5] and along the washes the sturdy and useful mesquite thrives. In the eastern districts mesquite is the characteristic growth; in the western areas the creosote bush, and in some alkaline regions the saltbush, are the most common plants. Even the mesquite areas are not so useful for range lands as they once were. Until about 1900, these areas were largely covered with perennial bunch grasses which provided good forage and helped to retain the topsoil. With increasing numbers of livestock, these grasses disappeared and the common grasses now are annuals which for forage must be supplemented by mesquite, cholla, saltbush, bur sage, and paloverde. Loss of the perennial grasses has also permitted considerable soil erosion, although there is little gullying because the valleys are flat.

Where the valleys rise to the foothills, and continuing over most of the low ranges, paloverde, ironwood, and giant saguaro cactus are the main stands.

5. The creosote bush does furnish fuel, a gum with which the Papago mend pottery, and it has some medicinal uses. But animals will eat it only in an extremity.

5: Castetter & Bell N-5 (1938-1940 1942
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CHAPTER V

SELECTION, DEVELOPMENT AND OWNERSHIP OF LAND

SELECTION AND LOCATION OF CULTIVATED LAND

Selection of land by the Gila Pima did not present a difficult task, for the bottomlands of this river rather generally consisted of fertile soil, the main problem being to choose land which could be irrigated easily from the canals yet was not too low to drain readily. The soil at Sacaton is of uniform texture to a considerable depth, a sandy loam composed largely of fine sands and silt from the weathering of adjacent mountains. When first cleared of native vegetation it is deficient in organic material, although the large quantity of silt increases the water-holding capacity, and it responds very readily to methods of improvement. This soil is representative of considerable areas extending in narrow strips along the Gila, which are well adapted for farming when not impregnated with soluble salts.[1]

Comparatively little choice was exercised by the Pima in selecting soil either in general or for particular crops, although sandy soil was preferred for watermelons. Good land was indicated by its black color and a vigorous growth of wild plants, and these Indians, of course, knew that such soil was richer and had greater water-holding power than soils of lighter color, and that corn, for example, would have smaller ears on light, sandy soil. Practically the only additional caution to be observed in soil selection was the avoidance of land high in salinity. The Papago were little troubled with this, but the bottomlands of the Gila (and Salt) were in places heavily impregnated, a common characteristic of irrigated soils. This was observed on the Gila even in Mange's

[1] King, *Crop Tests at the Cooperative Testing Station*, pp. 7, 9.

5: Castetter & Bell N-5 (1938-1940) 1942
NU28 Papago NU28
Pima NU29

day, for he wrote that, continuing from Casa Grande toward the west, it appeared as though the land had been strewn with salt.[2] In 1871 Grossmann[3] noted that some of the soil on the reservation was strongly impregnated with salts. However, the Pima have long coped with the problem of salinity by repeated flooding of such land with muddy water to wash out this mineral content, and, more recently, by working manure into the soil (taught by the whites). The fact that the Pima have irrigated the bottomlands of the Gila for centuries, without finding it necessary to abandon any large sections of land due to accumulation of salts, bespeaks their ancient knowledge of how to manage the fields from this standpoint. Informants recognized saline soil by: (1) The appearance of a white incrustation on the surface; (2) tasting the soil; (3) a growth of saltbush *(Atriplex);* (4) the sticky nature of such soil when wet, and (5) that such soil creaked when one walked on it. They also knew that deposits of salts are more abundant on high spots than in lower portions of a field; that their native crops and wheat would not do well but that muskmelons would do better on saline soil than many other crops. Seeds of various crops would germinate in such soil and grow for a time, but would either die before reaching maturity or not yield a harvest. As wheat is a winter crop in the Pima area, consequently requiring less irrigation, it often can be grown successfully on soils of higher salinity than most summer crops would tolerate.

Tests at the Coöperative Field Station[4] recently have shown that the alluvial soil in the vicinity of Sacaton is adapted to many kinds of truck crops, provided the concentration of salts is not too great. Also, that by turning under heavy applications of farmyard manure and cover crops, followed by growing alfalfa on the land for two or three years, it is possible to reduce the salinity to a large extent. The

[2] Mange, *Luz*, p. 253.
[3] Grossmann, *The Pima Indians of Arizona*, p. 418.
[4] King and Loomis, *Agricultural Investigations*, p. 59.

5: Castetter & Bell N-5 (1938-1940 1942
NU28 Papago NU29
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Pi Pa B4 organic matter and deeply growing roots of alfalfa result in looser structure and texture of the soil, making it more permeable to water and thus permitting leaching of the salts to lower levels.

The Gila Valley contains large areas covered with white incrustations of salts deposited by the evaporation of water reaching the surface from beneath. A comparison of the total salt content of surface flow with that of the underflow indicates the former contains salts varying from 39.4 to 120.2 parts per 100,000 of water, with an average of 96.3; the salt content of the underflow varies from 68 to 160 parts in 100,000 with an average of 126.6. Nevertheless the underground water at Sacaton is regarded as better for irrigation than the average surface water of the river. Examples of successful irrigation by waters more saline than the Gila underflow are numerous.[5]

Pa 311 361 A Papago village was invariably a settlement of kin, and others entered it only by invitation or marriage. The three Papago reservations comprise eleven village units, the location of which has changed very little since Kino first visited them.[6] The determinant reason is ecological, for they were located in spots which were then, as now, the most suitable for cultivation. Usually the main villages are situated in the north-to-south valleys, their daughter villages extending along the valley in both directions, and their Wells, or winter villages, located in the foothills on either side of the valley.

Pa 134 Soil in the Papago country is principally adobe, ranging from hard compact stretches, resulting from the first decomposition of lava near the mountains, to finer deposits mixed with decomposed vegetable matter on the floor of the broad valleys. With few exceptions, such as near meridian 112 at the Mexican line, where there is light, loose sand, the soil of the valley bottoms is fairly rich.[7]

[5] Lee, *Underground Waters of Gila Valley*, pp. 61-2.
[6] Underhill, *Papago*, p. 58.
[7] Clotts, *Nomadic Papago Surveys*, p. 3.

7: Lumholtz N-5 (1909-1910)1912
NU28 Papago NU28

778 offering. The jar is buried in the ground and a small
782 mound made above it, the central part of which is covered by a flat stone. Ocotillo sticks, stripped of bark, are placed upright, two toward the east and two toward the west, and empty cartridges, bits of glass, small seashells, as well as pebbles, had been deposited here. The little shrine is just outside of the rancheria, toward the end of the slope that runs down gently from the mountains near by. The rain-water, in times gone by, had
[134] formed furrows and small arroyos everywhere, making the country look wavy. The earth around the roots of the ever-present greasewood bushes resists the short-lived torrents, and they presented the same appearance of growing high above the ground on top of mounds which usually is due to the action of the wind. At one place where the ground was level a vast number of light yellow flowers were growing, forming a carpet-like covering among the greasewood. Quantities of broken pottery were lying about to the north-east of the small shrine and here, according to tradition, was the former site of the rancheria.

361 In spite of my satisfactory meeting with the Keeper of the Smoke, he seemed to have efficiently blocked my purchase of any more important objects, so I decided to make a tour of the several rancherias to the north, where the sway of my uncompromising and despotic friend did not reach; perhaps on my return conditions might change. The next rancheria to the north is Ánekam, hardly three miles away, but it is a community distinct from the preceding one and even more primitive. In

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Soils and Minerals. The greatest portion of the Papago Reservation is composed of alluvium weathered from the scattered hills and mountains, and which grades from coarse to fine as distance increases from the source. In the valley floors the soil varies from fine sand to sandy clay and clay, all suitable for agriculture where water is available.

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Although in the latter part of the nineteenth century ~~mining~~ brought large numbers of people to the Papago country and several sizable settlements flourished for brief periods, mineral resources have not yet been discovered which would be suitable for large-scale, long-term development. No oil or gas has been found, and promising formations are absent. Highly mineralized formations, mainly Pre-Cambrian and Mesozoic, have produced limited amounts of gold, silver, lead and manganese. Workable copper deposits exist close to and on the San Xavier Reservation, and are being mined on a large scale.

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Climate. The Sonoran Desert, in which the Papago country lies, is part of a series of deserts occupying about 440,000 square miles in the southwestern U. S. and northwestern Mexico. It is desert in both the colloquial and technical senses, with potential evaporation 8 to 10 times greater than rainfall. Although long records of rainfall, temperature, and other details of weather are scanty for the Papago Reservation, recent records can be used in conjunction

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Soil and Erosion. Since farming and stock raising 134 311
are important means by which the Papagos use the resources of their reservation, the nature and especially the present condition of their soils is of great importance. The soils of the area include much fine alluvial material, and frequently have only very sparse coverage of vegetation. Much of this cover has been reduced by overgrazing, and even before the introduction of stock there were numerous areas where heavy summer showers or the frequent strong winds of the dry spring period caused substantial erosion. By no means all of this could be prevented, but increased erosion within the past century has seriously interfered with flood water farming by cutting deep gullies where water formerly spread out on alluvial plains and by depositing coarse unsorted material on top of cultivable land.

Periodic surveys of the reservation have recorded 134
the extent and severity of erosion (see Soil Conservation Program, 20-Year Period). Wind erosion is particularly serious in the lighter soils of the Chukut Kuk, Pisinimo, Schuk Toak, and Sif Oidak districts. All districts have extensive gully erosion on steeper slopes. Sheet erosion on flatter areas occurs particularly in Baboquivari, Gu Achi, and Hickiwan districts. Nearly half of the 10,297 acres of the Gila Bend Reservation are classed as showing Severe or Critical erosion. About a third of the San Xavier Reservation (25,210 out of 71,090 acres) are Severe or Critical.

134 On the main Papago Reservation, erosion is reported as follows:

Slight	193,534
Moderate	1,183,840
Severe	1,160,060
Critical	237,800
	2,774,534

The individual districts, arranged in descending order of magnitude, are reported in Table 2. It is apparent from these figures and from a 1948 map of erosion conditions on the reservation, that large relatively flat areas in Schuk Toak District (especially on the southwest side of Aguirre Wash), in Gu Achi and Sif O'dak Districts (along Santa Rosa Wash), and in Chukut Kuk District are critically eroded, together with smaller areas in Sells, Baboquivari, and Pisinimo. Severe erosion is present in nearly all parts of the reservation, and the moderate or slight erosion areas tend to be concentrated in the central, southeast, and extreme northwest parts of the reservation.

[185] [312] Both in order to increase grass for forage and to control erosion, extensive areas have been provided with earth dams and with spreader dikes designed to distribute water more evenly and reduce the rapid and damaging runoff [311] from summer storms. Nevertheless, erosion continues to be a serious problem and its effects limit both carrying capacity for stock and possibilities for flood water farming.

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Table 2. Soil Erosion Conditions on the Papago Reservation, In Acres (Based on Data in Files of Branch Of Lar. Operations, Papago Indian Agency, Sells)

	Slight	Moderate	Severe	Critical	Total
Schuk Toak	13,774	97,920	252,160	92,800	456,654
Sif Oidak	44,800	189,440	178,880	22,628	425,748
Hickiwan	38,400	171,520	68,723	5,142	373,782
Gu Achi	4,860	119,680	157,440	11,025	293,025
Chukut Kuk	24,960	103,040	103,520	48,765	284,285
Pisinimo	16,640	126,720	127,560	10,960	281,680
Gu Vo	29,440	110,074	90,240	2,560	232,314
Sells	4,480	127,846	58,240	24,960	215,258
Baboquivari	16,180	136,960	38,400	19,360	210,882

Note: The Soil Erosion Service categorizes these conditions thus:

Slight: No apparent acceleration of normal geological erosion.

Mode ate: Less than 5 inches of topsoil removed.

Severe: From 5 to 9 inches of topsoil removed.

Critical: More than 9 inches of topsoil removed.

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Availability of Water. As is true of all of Arizona south of the Gila River, water for the Papago Reservations must come from deep wells. Water from this source, in proven or probable quantity (more than 200 gallons per minute), occurs in three broad valleys, evenly spaced from east to west across the main reservation and in four localities along the northern, southern, and eastern borders (see map 3).

the three reservations. Thirteen years later, in 1962, the amount of land used had decreased even though, at San Xavier, non-Indian farmers had been brought in to use idle land. Falling markets, a falling water table, and rising costs are perhaps the principal contributing factors in the failure to proceed with plans for the development of Chuichu. The almost complete abandonment of farming by San Xavier families has not been explained. Relatively small Indian holdings, continued division of the land among heirs, and the preference for wage work over subsistence farming are probably the primary contributing factors.

The prospect for a greater development of agriculture on the reservations has not, however, been abandoned by the Indians nor by students of agricultural economics. Mr. William H. Metzler, who conducted a study on the reservation during 1958 and 1959 for the Department of Agriculture, has estimated from a preliminary report by the U. S. Geological Survey that about 15,000 acres of land on the Papago Reservation could be irrigated from deep wells. He goes on to say (Metzler, 1959, pp. 46-7):

> "Less than one per cent of the approximately 3,000,000 acres in the reservation is adapted to crop production. Probably half of these 30,000 acres could be irrigated, the rest could be made suitable for flash flood farming. It is probable, however, that the Papagos do not need that much land for flood plain farming. Probably fewer than 300 families would engage in it and most would require only three to five acres each.

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"Some Papagos, however, have discovered a wider use for this type of farming. Some families have as much as 40 flood-plain acres devoted to the production of grain and forage crops for their livestock. Since this type of use is feasible, productive use of the entire flood-plain acreage on the reservation might be made.

"The tools and techniques used in flood-farming can be greatly improved so as to reduce the time required for constructing dykes and ditches, and for plowing, planting, weeding, and harvesting. . .

"A much sounder type of agriculture for the Papago family is irrigated subsistence farming. It fits in with their tradition of small farms and home food production. But it also assures adequate amounts of moisture and the timing of application so as to guarantee good yields. It would combine well either with off-farm employment or with livestock production."

Whether or not such a development as Metzler visualizes could be brought about will depend upon the cost of pumping water from deep wells (see Ground Water Report, page 27). It will also depend upon new regulations, opportunities and ideas with respect to land tenure, capital expenditures, and credit, not to mention the attitudes and interests of

241 Papago Indian families. The present generation of Indian farmers, with few exceptions, have not been successful in

[434] industrialized large-scale farming. From two to three hundred Papago families have, however, continued to grow subsistence and feed crops on small flood water farms as

000 a source of supplementary income. It is possible that some of these farmers would welcome a more stable farm income through the development of small irrigated plots, and that

3: Whited G-5 (1890) 1894 NT15 River Yumans
Papago NU28

133 PHYSICAL CHARACTERISTICS OF THE REGION.—The territory covered by the Papagos in their migrations, and
134 in which their villages are located, consists of mountain ranges and the intervening valleys. The soil of the valleys contains a considerable proportion of clay, so that it is all called adobe soil. In the mesas or plains occasional strips of sand occur. Along the arroyos, or dry water channels, deposits of gravel are numerous. The arroyos become raging torrents during the rainy season, rendering travel impossible or dangerous during the temporary flood. The soil of the foothills is very rocky. Alkali is present in the soil in varying proportions, giving the characteristic name to the vast stretch of country known as the alkali desert. It is not the presence of alkali, however, that makes the desert, but the absence of water. An abundant water supply renders this alkali soil equal in fertility to any soil in the country. As it is, the valleys contain a great deal of arable land,
137 which is evident from the great areas covered with grass, which form the stock ranges, and from occasional sections where weeds grow so luxuriantly after the rainy season as to overtop a man on horseback. Some portions of the valleys are covered with mesquite trees and bushes, and also sagebrush, but these sections produce abundant crops when irrigated.

132 CLIMATE.—The climate is very mild, being neither extremely cold in winter nor hot in summer. The mean average temperature during the summer of 1889 was 81.5°, and during the winter of 1889–1890 it was 52.6°.

312 WATER SUPPLY.—There are occasional wells found among the Indian villages. Natural water holes are quite numerous, and by raising embankments of earth in favorable localities the Papagos make huge ponds or reservoirs, which they call tanks. These natural and artificial reservoirs are only serviceable for the temporary storage of water, and toward the last they become filthy mudholes. The Indians, however, continue to use the water as long as it can possibly be considered a fluid. In one place the Papagos have dug a well 60 feet deep, and with incredible labor have made a footpath from the top of the ground to the level of the water.

Water is found by boring at a depth of from 200 to 800 feet, but no flowing wells have yet been obtained in the territory. The water in the wells rises from 50 to 150 feet, and then is raised to the surface by steam pumps. The Indians, however, have not the financial resources with which to sink or operate artesian wells. When their tanks are exhausted they remove with droves and herds to the valleys and canyons in the mountains, frequently crossing over into Mexico.

137 TIMBER.—The varieties of timber within the Papago range are the willow, cottonwood, mesquite, palloverda, and on the southern and western mountain slopes the oak. The mesquite is the most common timber, as it grows freely on the mesas. It rivals the hickory as firewood, throwing out great heat, and the coals retain fire even longer than coals of hickory. The mesquite, however, is very easy to cut, and is handled with far less labor than hickory.

137 FRUITS AND NUTS.—The sahuaro (giant cactus), which grows on the rocky soil of the foothills and covers the moderate mountain ranges, rises in height from 10 to 60 feet, and is a mass of vegetable matter, supported by an internal skeleton of ribs or poles of woody fiber. The fruit of this remarkable plant grows out of the top of the trunk and arms, and constitutes an important article of food, the Papagos almost living upon it during June, July,
272 and a part of August. They gather it with long poles, and eat it either fresh or after it has been dried. They make
267 from the juice a sirup and a drink which is slightly charged with alcohol. Although the ribs of the sahuaro are
[273] very valuable, the Indians never destroy the plant, and are greatly incensed if a white man cuts one down; but
[313] when the cactus dies and the vegetable matter dries, powders, and falls away, leaving the ribs exposed and bare, they are used as supports for the dirt roofs of adobe houses, for the sides of houses when plastered with mud, for poultry and pigeon houses, and other small structures.

262 The Papagos eat the fruit of the prickly pear cactus and make a sirup from its juice; from the mesual (sweet
[273] aloe) a highly intoxicating drink is made. The root, which is bulbous, grows partly under and partly above the ground, and when roasted it is very delicious, and great quantities are consumed by the Papagos. They dig out of the ground a vegetable which appears to be a species of wild onion, but they call it a groundnut, and relish it
[388] highly when boiled. A very useful plant found in large quantities, called the soap plant (amole), forms a substitute for soap.

282 The tannin root, resembling the sweet potato in appearance, grows in great profusion. It contains a large portion of tannic acid, and is a substitute for the astringent barks, hemlock and oak, which are used in tanneries.

262 FOOD.—In addition to the fruits, nuts, and flesh already mentioned, their food consists of wheat flour (usually
252 formed by the women on a metate) prepared in simple ways, parched wheat and corn, boiled wheat and corn, flour made from the mesquite bean, beans, boiled squash, green and dried squash seeds, beef, and poultry.

181 INDUSTRY.—The Papagos seem to be esteemed by the whites in general as the best Indians in the territory.
[464] They are industrious, and are good help in mines, on ranches, in the harvest field, and on stock ranges. They easily learn the mechanical arts, and set and handle mining drills as well as white men. The engineer at the Quijotoa mines said that his assistant was a Papago, and that he was fully competent to run the engine.

[312] In practical irrigation the Indians are conceded to be the superiors of the whites, and in their domain this is the foundation of agricultural skill. When properly educated there can be no doubt of their ability to acquire the scientific principles of the art.